

The conservation value of small woodland remnants on the New South Wales South Western Slopes: a case study from Wagga Wagga

Michael J. Murphy

NSW National Parks and Wildlife Service, NPWS Northern Zone,
Locked Bag 914, Coffs Harbour, New South Wales 2450

ABSTRACT

A survey of the bird and non-flying mammal fauna in Pomingalarna Park, a small woodland remnant near Wagga Wagga, on the New South Wales South Western Slopes, recorded 91 native bird species and five native mammal species. Three introduced bird species and eight introduced mammal species were also recorded. The woodland is an association of Western Grey Box *Eucalyptus microcarpa*, Blakely's Red Gum *E. blakelyi* and White Cypress Pine *Callitris glaucophylla*. The results highlight the significance of small remnants for the conservation of biological diversity in the New South Wales South Western Slopes region.

Key words: Birds, Mammals, New South Wales South Western Slopes, Temperate woodland, Remnant vegetation, Variegated landscape, Conservation.

INTRODUCTION

Before European settlement, the New South Wales South Western Slopes region, in inland southeastern Australia (Thackway and Creswell 1995), supported extensive stands of temperate box woodland (Gall 1982; Morgan and Terrey 1992; Prober and Thiele 1993). Today this area is one of Australia's primary agricultural and pastoral regions, and an estimated 80% of the region has been cleared (State of the Environment Advisory Council 1996). Scattered elements of the original vegetation are typically all that remain in a predominantly cleared rural landscape (Morgan and Terrey 1992; Prober and Thiele 1993; Sivertsen 1993).

The landscape of the region today corresponds to the habitat variegation model described by McIntyre and Barrett (1992): remnant woodland areas of various sizes, roadside and riparian vegetation, grazing lands of native and improved pasture with or without scattered trees, and cropped areas all contributing to a varying spectrum of suitable habitat for different native species. Even quite small native vegetation remnants within this habitat matrix can be of conservation value for many native species (Barrett *et al.* 1994). The long-term survival of the current variegated landscape is under threat owing to the continuing loss of essential native vegetation components through clearing and degradation of remnant areas and senescence and death of isolated mature trees in farmland.

Observations of the birds and non-flying mammals in a typical small woodland remnant near Wagga Wagga, New South Wales, were

made during a series of visits to the area over a five year period. The results are presented here to illustrate the significance of small remnants for the conservation of biological diversity and the distinctiveness of the New South Wales South Western Slopes.

STUDY AREA

Pomingalarna Park (35°07'S, 147°18'E) (Figs 1 and 2) is 225 ha in area and occupies a low wooded ridge of Ordovician shale on the western outskirts of the Wagga Wagga urban area. The elevation ranges from 200 to 298 m AHD. The Park is a crown reserve and is managed by the Wagga Wagga City Council as a public recreation reserve. The history of the Park dates back to 1881 when an original 427 ha were dedicated as a Common.

The vegetation has regenerated following grazing and quarrying activities in the past, and provides important habitat features for native woodland fauna, including hollow-bearing trees, fallen timber and an understorey with a range of native grass, herb and shrub species.

Three broad habitat types were identified in the study area: woodland with an understorey of grasses and shrubs (about 87 ha) (Fig. 3), open woodland with a grassy understorey (about 94 ha) (Fig. 4) and grassland (about 44 ha) (Fig. 5). A stock dam and an abandoned quarry provide small areas of aquatic habitat.

Approximately 165 plant species have been recorded in the Park, including 53 non-indigenous native or introduced alien species (R. Good, NSW NPWS, pers. comm.). The predominant tree species in the study area

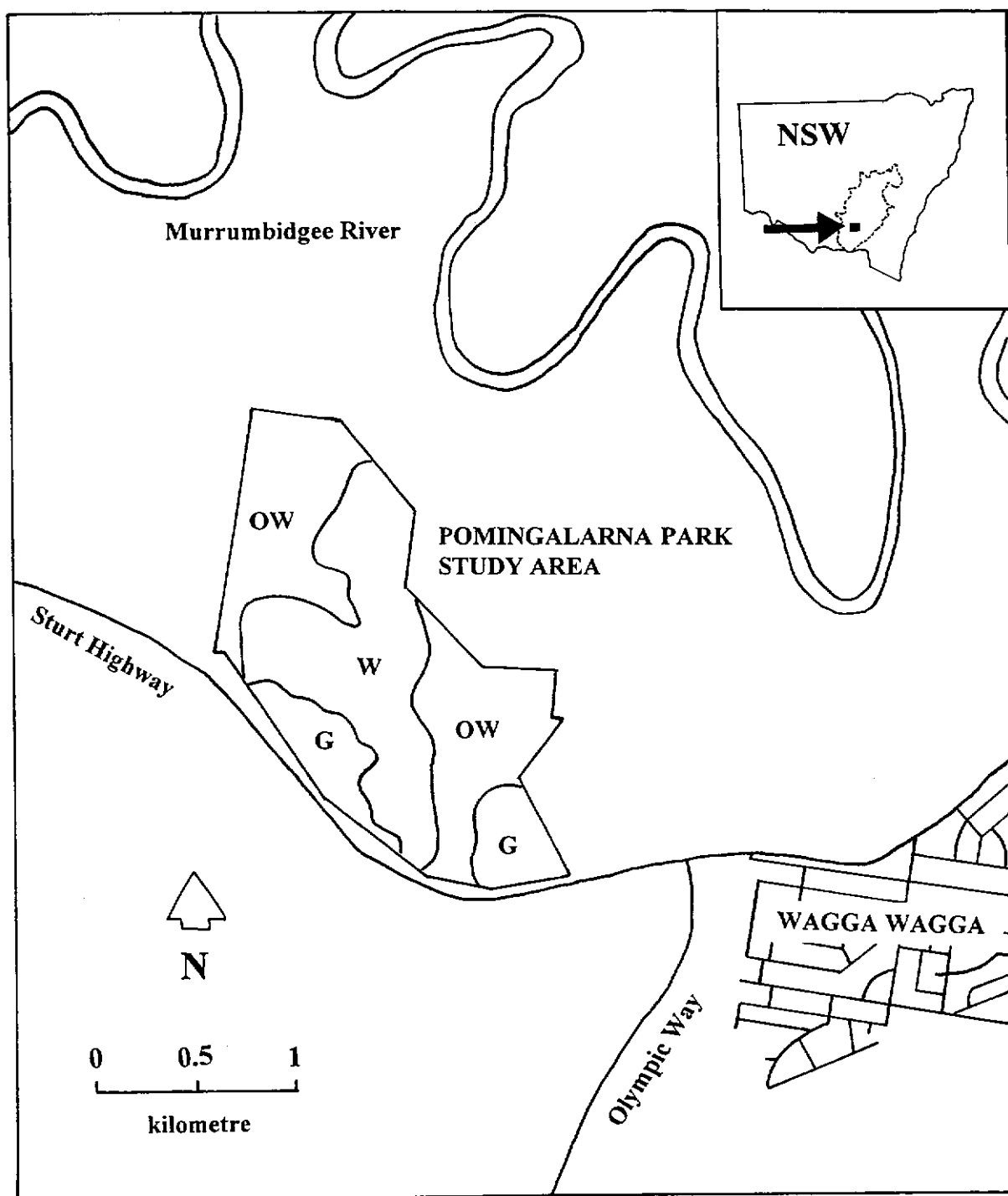


Figure 1. Location of the Pomingalarna Park study area near Wagga Wagga in the New South Wales South Western Slopes Biogeographic Region. The 225 ha study area occupies a low ridge bordering the Murrumbidgee river flats. Broad habitat types within the study area are mapped: W = woodland, OW = open woodland, G = grassland.



Figure 2. An aerial view of Pomingalarna Park and surrounding farmland in 1995. Extensive clearing of the original Box woodland and River Red Gum riverine forest since European settlement of the Wagga Wagga area in 1832 has resulted in the present variegated landscape, where woodland/forest remnants, roadside and riparian vegetation, grazing land with scattered mature trees and cropped areas provide a spectrum of suitable habitat for different native species. Aerial Photography supplied by The Sydney Map Shop, 23–33 Bridge Street, Sydney, New South Wales 2000.

are Western Grey Box *Eucalyptus microcarpa*, Blakely's Red Gum *E. blakelyi* and White Cypress Pine *Callitris glaucophylla*. White Box *E. albens* and Yellow Box *E. melliodora* are also present. Understorey species include Kangaroo Grass *Themeda australis*, Wallaby Grass *Danthonia caespitosa*, spear grass *Stipa* spp., Sticky Everlasting *Bracteantha viscosa*, burr daisies *Calotis* spp., Parrot Pea *Dillwynia sericea*, Austral Indigo *Indigofera australis*, Drooping She-oak *Allocasuarina verticillata* and wattles *Acacia* spp. Grasses (Poaceae) and daisies (Asteraceae) in particular are well represented in the understorey, each with about 25 species present (R. Good, pers. comm.).

METHODS

Observations of the birds and non-volant mammals occurring in the study area were collated from 13 visits to Wagga Wagga between March 1992 and July 1997. The study area was visited on a total of 39 days and 19 nights during this period. Survey methods consisted of direct observation by day, spotlighting, listening for bird calls, mammal trapping and identification of indirect signs.

1. Diurnally active birds and mammals were directly observed while walking or slowly driving through the study area by day. Binoculars (7 × 50) were used to aid observation.
2. Spotlighting for nocturnal birds and mammals, using a 50 watt spotlight either from a car or on foot, was done between dusk and 22:00 in sessions averaging one to two hours, and totalled 28 hours.
3. Birds were identified by call during diurnal surveying and spotlighting by night. Species with unfamiliar calls were tracked down and identified by sight.
4. Aluminium Size A Elliott traps baited with a peanut butter/rolled oats mixture were set (60 trap-nights) for small terrestrial mammals.
5. Birds were indirectly recorded by identification of vacant nests and feeding remains. Indirect signs of mammals included tracks, scats, diggings and skeletal remains. Fifteen regurgitated pellets from the daytime roost of a Barn Owl and five Fox scats collected from different parts of the study area were analysed for hair content by Barbara Triggs (Genoa, Victoria).
6. Status. The abundance of each species recorded during the survey was classified on the basis of frequency of observation. Species were classed as rare if an individual or group was recorded only once during the survey, uncommon if they were recorded on more than one occasion but

less than 25% of site visits, common if recorded between 25% and 75% of site visits, and abundant if recorded on more than 75% of site visits.

RESULTS

Birds

Ninety-one species of native birds (from 38 families) and three species of introduced birds (from three families) were recorded during the study (Table 1). Two species are considered to be of state conservation significance: the Superb Parrot (vulnerable) and Gilbert's Whistler (vulnerable) (New South Wales *Threatened Species Conservation Act 1995*).

The open woodland had the greatest number of species of birds recorded (60 spp.), followed by woodland (45 spp.), grassland (26 spp.) and aquatic habitat (16 spp.). Birds of the aquatic habitat included terrestrial species visiting to drink or bathe as well as wetland species. Five species were recorded flying at height over the study area.

Based on the frequency criteria, 14 bird species were abundant in the study area, 17 were common, 43 were uncommon and 20 were rare. Abundant species included the Galah, Brown Treecreeper, White-plumed Honeyeater, White-browed Babbler and Australian Magpie.

Introduced species were only a minor component of the avifauna. The three introduced species were uncommon in the study area, although they were widespread and common in the surrounding area.

Mammals

Five species of native mammals (from four families) and eight species of introduced mammals (from five families) were recorded (Table 2). Insectivorous bats were not surveyed but were noted to occur on site, and were considered likely to have daytime roosts there.

The woodland had the greatest number of species of mammals recorded (10 spp.), followed by open woodland (9 spp.) and grassland (5 spp.). Native species occurred predominantly in the woodland and open woodland habitats, while introduced species occurred in all habitats. One species, the Domestic Sheep, occurred in the surrounding farmland and was only recorded within the study area as remains in a Fox scat.

Based on the frequency criteria, two mammal species were abundant in the study area, two were common, five were uncommon and four were rare. Abundant species were the Eastern Grey Kangaroo and the introduced European Rabbit.

Table 1. Bird species recorded in Pomingalarna Park between 1992 and 1997. Method of detection: D = diurnal observation, S = spotlighting, C = identification by call, I = indirect sign (vacant nest or feeding remains identified). Habitat: W = woodland, O = open woodland, G = grassland, A = aquatic, H = overhead at height. Status in Study Area: R = rare, U = uncommon, C = common, A = abundant. Note: nomenclature follows Christidis and Boles (1994).

Family	Species	Common name	Method	Habitat	Status
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail	D	O, G	U
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck	D, C	O, A	U
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	D	A	R
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant	D	H	R
Pelicanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican	D	H	R
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron	D	A	U
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron	D	A	R
Ardeidae	<i>Ardea alba</i>	Great Egret	D	A	R
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis	D	H	R
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite	D, C	O, G	C
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	D, C	O, G	U
Accipitridae	<i>Accipiter</i> sp.	Br. Goshawk/C. Sparrowhawk	D	W, O	U
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle	D	H	U
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle	D	O, G	C
Falconidae	<i>Falco berigora</i>	Brown Falcon	D	O, G	U
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel	D	O, G	C
Turnicidae	<i>Turnix varia</i>	Painted Button-quail	D	W	C
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	D, C	A	U
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing	D	O	U
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon	D	O, G	C
Columbidae	<i>Geopelia cuneata</i>	Diamond Dove	D	G	R
Columbidae	<i>Geopelia striata</i>	Peaceful Dove	D, C	W, O, G, A	A
Cacatuidae	<i>Cacatua roseicapilla</i>	Galah	D, C	O, G, A	A
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	D, C	O, G	C
Cacatuidae	<i>Nymphicus hollandicus</i>	Cockatiel	D	O	R
Psittacidae	<i>Glossopsitta pusilla</i>	Little Lorikeet	D, C	W, O	C
Psittacidae	<i>Polytelis swainsonii</i> ¹	Superb Parrot	D	O	R
Psittacidae	<i>Platycercus elegans</i>	Crimson (Yellow) Rosella	D, C	W, O	A
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	D, C	W, O	U
Psittacidae	<i>Psephotus haematonotus</i>	Red-rumped Parrot	D	W, O, G, A	A
Psittacidae	<i>Melopsittacus undulatus</i>	Budgerigar	D	O	R
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	D, C	W	U
Cuculidae	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo	D	O	R
Strigidae	<i>Ninox novaeseelandiae</i>	Southern Boobook	D	W	R
Tytonidae	<i>Tyto alba</i>	Barn Owl	S, I	W, O	U
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth	S, C	W	U
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	D, C	O	A
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	D, C	W	U
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	D, C	O	C
Climacteridae	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	D, C	W	U
Climacteridae	<i>Climacteris picumnus</i>	Brown Treecreeper	D, C	W, O	A
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	D, C	O	C
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	D, C	W	U
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote	D, C	O	U
Pardalotidae	<i>Chthonicola sagittata</i>	Speckled Warbler	D	W	U
Pardalotidae	<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	D	W	U
Pardalotidae	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	D	W	R
Pardalotidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	D	O, G	C
Pardalotidae	<i>Acanthiza nana</i>	Yellow Thornbill	D	W, O	C
Pardalotidae	<i>Aphelocephala leucopsis</i>	Southern Whiteface	D	O, G	U
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird	D, C	W, O	U
Meliphagidae	<i>Philemon citreogularis</i>	Little Friarbird	D	W	U
Meliphagidae	<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	D	O	R
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	D, C	O	C
Meliphagidae	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	D, C	W, O, A	A
Meliphagidae	<i>Melithreptus</i> sp.	Honeyeater sp.	D	W	U
Meliphagidae	<i>Epthianura tricolor</i>	Crimson Chat	D	O	R
Petroicidae	<i>Petroica multicolor</i>	Scarlet Robin	D	W	R
Petroicidae	<i>Petroica goodenovii</i>	Red-capped Robin	D	O	U
Petroicidae	<i>Petroica phoenicea</i>	Flame Robin	D	W, O	U
Petroicidae	<i>Melanodryas cucullata</i>	Hooded Robin	D	W, O, G	C
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	D, C	W	C
Pomatostomidae	<i>Pomatostomus superciliosus</i>	White-browed Babbler	D, C, I	W, O	A
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	D	W	R
Pacycephalidae	<i>Falcunculus frontatus</i>	Crested Shrike-tit	D, C	W	U
Pacycephalidae	<i>Pachycephala inornata</i> ¹	Gilbert's Whistler	D	W	U
Pacycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	D, C	W	U
Pacycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	D	O	U

Continued on page 77



Figure 3. Woodland habitat in Pomingalarna Park. Photograph by Michael Murphy.



Figure 4. Open woodland habitat in Pomingalarna Park. Photograph by Pam Rawle.



Figure 5. Grassland habitat in Pomingalarna Park. Photograph by Michael Murphy.



Figure 6. Brown Quail *Coturnix ypsilophora* observed during diurnal survey in open woodland at Pomingalarna. This shy species occurs in small groups in areas with tall, dense grass cover, and is absent from heavily grazed areas. Photograph by Michael Murphy.



Figure 7. Tawny Frogmouth *Podargus strigoides* observed during spotlighting in woodland at Pomingalarna. While currently relatively common in the region, this species is likely to decline if native vegetation components of the present variegated landscape continue to disappear. Photograph by Michael Murphy.

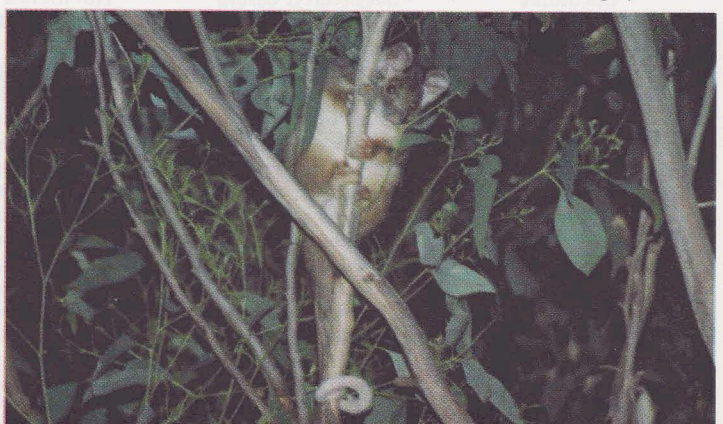


Figure 8. Common Ringtail Possum *Pseudocheirus peregrinus* recorded during spotlighting in woodland at Pomingalarna. This species is totally dependent on remnant woodland and riverine forest in the region. Photograph by Michael Murphy.



Figure 9. Restless Flycatcher *Myiagra inquieta* in open woodland at Pomingalarna. This species was often detected by its characteristic harsh, grating call. Another common name for the species is the Scissors-grinder. It occurs in woodland and open forest, often near water. Photograph by Michael Murphy.

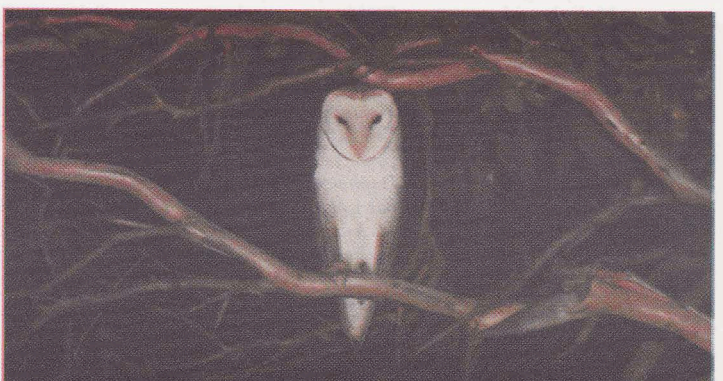


Figure 10. Barn Owl *Tyto alba* in open woodland at Pomingalarna. This species was also recorded indirectly by identification of an old roost site. Analysis of regurgitated pellets from this roost indicated that the owl had preyed exclusively on the introduced House Mouse *Mus musculus*. Photograph by Michael Murphy.

Table 1 — continued.

Family	Species	Common name	Method	Habitat	Status
Pacycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	D, C	W, O	A
Dicruidae	<i>Myiagra inquieta</i>	Restless Flycatcher	D, C	O, G	U
Dicruidae	<i>Grallina cyanoleuca</i>	Magpie-lark	D, C, I	O, G, A	C
Dicruidae	<i>Rhipidura fuliginosa</i>	Grey Fantail	D	W	U
Dicruidae	<i>Rhipidura leucophrys</i>	Willie Wagtail	D, C	W, O, G, A	A
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	D	W, O	C
Campephagidae	<i>Lalage sueurii</i>	White-winged Triller	D	O	U
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole	D, C	W	U
Artamidae	<i>Artamus superciliosus</i>	White-browed Woodswallow	D	O	U
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow	D	W, O, H	U
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	D	O	U
Artamidae	<i>Gymnorhina tibicen</i>	Australian Magpie	D, C	O, G, A	A
Corvidae	<i>Corvus coronoides</i>	Australian Raven	D, C	W, O, G	A
Corcoracidae	<i>Corcorax melanorhamphos</i>	White-winged Chough	D, I	W	U
Motacillidae	<i>Anthus novaeseelandiae</i>	Richard's Pipit	D	G	U
Passeridae	<i>Passer domesticus</i> ²	House Sparrow	D	O, G	U
Passeridae	<i>Taeniopygia bichenovii</i>	Double-barred Finch	D, C	O, G	A
Passeridae	<i>Stagonopleura guttata</i>	Diamond Firetail	D, C	W, O	C
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird	D	W	R
Hirundinidae	<i>Cheramoeca leucosternum</i>	White-backed Swallow	D	W	R
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	D	W, O, G, A	A
Hirundinidae	<i>Hirundo nigricans</i>	Tree Martin	D	W, O, G, A	U
Hirundinidae	<i>Hirundo ariel</i>	Fairy Martin	I	O	R
Sylviidae	<i>Cincloramphus mathewsi</i>	Rufous Songlark	D, C	O	U
Muscicapidae	<i>Turdus merula</i> ²	Common Blackbird	D, C	O	U
Sturnidae	<i>Sturnus vulgaris</i> ²	Common Starling	D	O, G	U

¹Vulnerable species in New South Wales Threatened Species Conservation Act 1995.²Introduced species.

Table 2. Mammal species recorded in Pomingalarna Park between 1992 and 1997. Method of detection: D = diurnal observation, S = spotlighting, E = Elliott trapping, F = prey in fox scat, O = prey in owl pellet, I = other indirect signs (scat, tracks or skeletal remains). Habitat: W = woodland, O = open woodland, G = grassland. Status in Study Area: R = rare, U = uncommon, C = common, A = abundant. Note: nomenclature follows Strahan (1995).

Family	Species	Common name	Method	Habitat	Status
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	D	W	R
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	S	W, O	U
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	S, I	W, O	U
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	D, S, I	W, O, G	A
Macropodidae	<i>Wallabia bicolor</i>	Swamp Wallaby	D, S, I	W, O	C
Muridae	<i>Mus musculus</i> ¹	House Mouse	S, E, F, O	O	U
Canidae	<i>Canis familiaris</i> ¹	Domestic Dog	D, F, I	W, O, G	C
Canidae	<i>Vulpes vulpes</i> ¹	Red Fox	D, I	W, O, G	U
Felidae	<i>Felis catus</i> ¹	Feral Cat	I	W	R
Leporidae	<i>Oryctolagus cuniculus</i> ¹	European Rabbit	D, S, F, I	W, O, G	A
Leporidae	<i>Lepus capensis</i> ¹	Brown Hare	D, S	O, G	U
Bovidae	<i>Capra hircus</i> ¹	Domestic Goat	D	W	R
Bovidae	<i>Ovis aries</i> ¹	Domestic Sheep	F	—	R

¹Introduced species.

DISCUSSION

Birds

The terrestrial avifauna of the study area was diverse, and included resident species, irregular visitors and seasonal migrants. Waterbirds were only occasional visitors, owing to the limited area of suitable habitat present. Given the duration of the survey, it is considered that most resident bird species present in the study area were identified. However, it is likely that additional irregular visitors and seasonal migrants would be recorded if further work was done. An earlier study at Pomingalarna by Degabriele *et al.* (1979) identified significant seasonality in

the composition of the avifauna, and recorded one species, the Brown Thornbill *Acanthiza pusilla*, which was additional to the present study.

The avifauna reflects the location of the New South Wales South Western Slopes in the transitional zone between the coastal Bassian and arid Eyrean faunal assemblages (Kikkawa and Pearse 1969; Schodde 1979). Bassian species recorded include the Little Lorikeet, Flame Robin, Eastern Yellow Robin, Golden Whistler and Dusky Woodswallow. Eyrean species include the Budgerigar, Crimson Chat, Chestnut-rumped Thornbill and Southern Whiteface.

The number of species of birds recorded was high compared to that recorded in many, considerably larger, remnants in the region (Gall 1982). This is in part related to the presence of both wooded and open habitats in the study area, and partly to the duration of the survey.

The avifaunas of agricultural areas represent a spectrum of grades of sensitivity to clearing and fragmentation (Loyn 1985; Barrett *et al.* 1994). At one end of the spectrum are those species favoured by clearing through being either open country species, or forest/woodland species tolerant of disturbance and fragmentation. At the other end are those species disadvantaged by clearing as a result of their reliance on intact areas of forest/woodland.

Species towards the open country or disturbance-tolerant end of the spectrum recorded at Pomingalarna include the Black-shouldered Kite, Crested Pigeon, Galah, Noisy Miner, Australian Magpie, Australian Raven and Welcome Swallow. These species occurred predominantly in the grassland and open woodland habitats in the study area. They occur widely throughout the South Western Slopes region, and their current regional status is secure.

Species towards the disturbance-sensitive end of the spectrum recorded at Pomingalarna include the Painted Button-quail, Common Bronzewing, Brown Treecreeper, Speckled Warbler, Buff-rumped Thornbill, Hooded Robin, White-browed Babbler, Crested Shrike-tit, Gilbert's Whistler and Diamond Firetail. These species are considered to be of regional conservation significance because their distribution in the region is largely restricted to the remaining remnants of the original vegetation. The woodland and open woodland habitats in the study area were the most important for these species, and it is noteworthy that a number were found to be common residents of the study area.

Woodland-dependent bird species, including many of those listed above, are in serious decline in agricultural regions across southern Australia (Saunders 1989; Lynch and Saunders 1991; Barrett *et al.* 1994; Robinson 1994; Barrett 1997; Bennett and Ford 1997). At least one-quarter of woodland bird species throughout Australia's temperate woodlands are believed to be declining (Robinson and Traill 1996). In addition to the direct reduction in available habitat through widespread clearing and fragmentation of woodland, these species also face increased competition from open country and disturbance-tolerant species for foraging resources (Loyn 1987; Cox and Bauer 1997; Grey *et al.* 1997)

and nesting resources (Saunders and Ingram 1987; Webster and Ahern 1992).

Species now absent but considered, based on assessment of historical range and availability of suitable habitat, to have possibly occurred in the study area previously, include the Emu *Dromaius novaehollandiae*, Australian Bustard *Ardeotis australis*, Bush Stone-curlew *Burhinus grallarius* and Barking Owl *Ninox connivens*. The Emu, Bush Stone-curlew and Barking Owl are uncommon and considered at risk in the region (Gall 1982), while the Australian Bustard is extinct in the region (Blakers *et al.* 1984).

Mammals

In contrast to the avifauna, the non-volant native mammal fauna of the study area was depauperate. Non-volant mammals are generally more prone to decline and extinction than birds and bats because of a combination of higher daily energy requirements (due to greater body size), lesser mobility, and greater propensity to isolation (Burbidge and McKenzie 1989). Decline and extinction of Australian mammals since European settlement has been greatest among medium-sized (Critical Weight Range) ground-dwelling species (Calaby 1971; Burbidge and McKenzie 1989; Kennedy 1992), and has been most severe in agricultural areas (Burbidge and McKenzie 1989; Saunders 1994). Only one CWR ground-dwelling native mammal species remains at Pomingalarna: the Short-beaked Echidna.

The low native mammal species diversity is a function of the small size and duration of isolation of the study area (Bennett 1987), as well as a reflection of the generally low extant native mammal species diversity in the South Western Slopes region (Gall 1982). Species extinct or greatly declined in the region since European settlement include the Spotted-tailed Quoll *Dasyurus maculatus*, Eastern Quoll *D. viverrinus*, Brush-tailed Phascogale *Phascogale tapoatafa*, Yellow-footed Antechinus *Antechinus flavipes*, Bilby *Macrotis lagotis*, Koala *Phascolarctos cinereus*, Common Wombat *Vombatus ursinus*, Sugar Glider *Petaurus breviceps*, Squirrel Glider *P. norfolcensis*, Bridled Nail-tail Wallaby *Onychogalea fraenata*, Brush-tailed Rock-wallaby *Petrogale penicillata*, Common Wallaroo *Macropus robustus*, White-footed Rabbit-rat *Conilurus albipes* and Dingo *Canis lupus dingo* (Watts and Aslin 1981; Gall 1982; Strahan 1995). It is likely that at least some of these species previously occurred in the study area. Previous records from Wagga Wagga include the Spotted-tailed Quoll in 1902 and the Bilby in 1912 (Gall 1982).

The regional conservation status of most extant native mammal species on the South Western Slopes is considered poor (Gall 1982), although many are common and secure elsewhere in their range. All five native mammal species recorded in this study were listed by Gall (1982) as poorly conserved in the region. All are dependent, to varying degrees, on remnants of native vegetation.

Introduced mammals are now a prominent part of the mammal fauna in the study area, occupying many niches vacated by CWR ground-dwelling native species. The species recorded in the analysis of Fox scats are typical of the prey of the Fox in agricultural areas in southeastern Australia (Coman 1973; Croft and Hone 1978). The native mammal species at Pomingalarna are all known to be preyed upon by feral predators in forest areas (Triggs *et al.* 1984; Lunney *et al.* 1990), and their absence from the Fox's diet in the present study is probably a reflection of their low abundance relative to the introduced prey species. Similarly, the reliance of the Barn Owl on the House Mouse reflects the abundance of mice in the area, and is consistent with published references to the Barn Owl's diet (Hollands 1991).

Although the identification of microchiropteran bat species was outside the scope of this study, it should be noted that they represent about one-fifth of Australia's native mammal species (Strahan 1995), and can constitute a significant component of an area's native mammal fauna. Gall (1982) recorded 12 microchiropteran bat species in the South Western Slopes region, comprising about one-third of the extant native mammal fauna in the region.

Conservation implications

Temperate box woodlands are among the most poorly conserved vegetation communities in New South Wales, and are most vulnerable or endangered in agricultural areas (Benson 1991). In the New South Wales South Western Slopes region less than 20% of the original woodland and forest cover remains, and only 1% of the region has been reserved for nature conservation (State of the Environment Advisory Council 1996). Because of the extent of clearing, opportunities for establishing large new conservation reserves in the region are limited (Morgan and Terrey 1992). There is therefore an urgent need to recognize the value of small remnants in conserving woodland fauna in the variegated landscape.

Morgan and Terrey (1992) recommended that all remaining Grey Box woodland remnants on crown reserves in the South Western Slopes

region be assumed to have high conservation value. This study has demonstrated that the Pomingalarna Park reserve provides habitat for a range of woodland fauna, including species of state and regional conservation significance. Woodland remnants of similar size occur throughout the region. The regional conservation of many woodland-dependent species in the moderate range of disturbance-sensitivity is supported by the habitat provided by these scattered smaller remnants (Barrett 1997).

Remnants of this size are too small to maintain viable populations *in vacuo*. Instead, the conservation of disturbance-sensitive woodland fauna in small remnants relies on the movement of individuals between remnants to maintain viable metapopulations. The probability of successful movement from one woodland remnant to another depends on the distance between remnants and the nature of the intervening matrix, and varies between species. The creation and enhancement of vegetated corridors linking small remnants can re-establish or assist movement between remnants, and broaden the range of woodland species able to maintain populations there (Merriam 1991; Saunders and de Rebeira 1991).

The most extreme disturbance-sensitive woodland fauna species, isolated in woodland remnants and unable to move from one to another, can only be conserved in larger-block reserves of sufficient size to support independent viable populations. Some of the species recorded at Pomingalarna may prove to be isolated relict populations of extreme disturbance-sensitive woodland fauna species, in the process of declining to local extinction. The Gilbert's Whistler, for example, which has disappeared from woodland remnants in the central wheatbelt of Western Australia (Saunders 1989) may belong to this category.

The preservation of habitat for native flora and fauna is a primary objective of the current management of Pomingalarna Park (Wagga Wagga City Council 1995). The area presently supports both open country fauna and a range of woodland fauna from disturbance-tolerant to disturbance-sensitive species. The final test of the conservation value of this small remnant will be whether it can maintain its current woodland-dependent fauna. The loss of these species from this and other remnants across the South Western Slopes would represent a significant loss of regional biodiversity and biodistinctiveness. The information from the present study provides a useful baseline for future assessment of changes in the status of species in the area.

Conclusion

The degradation of the wheat-sheep agricultural areas is one of the most serious conservation issues in Australia today (Saunders and Hobbs 1995; Robinson and Traill 1996). Overclearing of native vegetation has resulted in a decline in both biodiversity and agricultural productivity (Saunders 1994; Robinson and Traill 1996; Barrett 1997). The survival of much of the extant native fauna is linked to small, scattered remnants of the original vegetation. Sympathetic and co-ordinated management of these small remnants, involving co-operation between landowners and land management agencies, is essential if the surviving biodiversity is to be conserved.

ACKNOWLEDGEMENTS

The author wishes to thank Roger Good and Mick Andren for helpful discussions, two anonymous referees for their constructive comments on a draft of this manuscript, and Irma Noller for her hospitality during visits to Wagga Wagga. This research was undertaken under New South Wales Scientific Investigation Licence number A1362.

REFERENCES

- Barrett, G. W., 1997. Birds on farms: repairing the rural landscape. *Wingspan* 7(4): 10-15.
- Barrett, G. W., Ford, H. A. and Recher, H. F., 1994. Conservation of woodland birds in a fragmented rural landscape. *Pac. Cons. Biol.* 1: 245-56.
- Bennett, A. F., 1987. Conservation of mammals within a fragmented forest environment: the contributions of insular biogeography and autecology. Chapter 4 (Pp. 41-52) in *Nature Conservation: the Role of Remnants of Native Vegetation* ed by D. A. Saunders, G. W. Arnold, A. A. Burbidge and A. J. M. Hopkins. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Bennett, A. F. and Ford, L. A., 1997. Land use, habitat change and the conservation of birds in fragmented rural environments: a landscape perspective from the Northern Plains, Victoria, Australia. *Pac. Cons. Biol.* 3: 244-61.
- Benson, J., 1991. The effect of 200 years of European settlement on the vegetation and flora of New South Wales. *Cunninghamia* 2(3): 343-70.
- Blakers, M., Davies, S. and Reilly, P., 1984. *The Atlas of Australian Birds*. Melbourne University Press: Carlton, Victoria. 738 Pp.
- Burbidge, A. A. and McKenzie, N. L., 1989. Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biol. Cons.* 50: 143-98.
- Calaby, J. H., 1971. The current status of Australian Macropodidae. *Aust. Zool.* 16: 17-29.
- Christidis, L. and Boles, W. E., 1994. *The Taxonomy and Species of Birds of Australia and its Territories*. Royal Australian Ornithological Union Monograph 2.
- Coman, B. J., 1973. The diet of red foxes, *Vulpes vulpes* L., in Victoria. *Aust. J. Zool.* 21: 391-401.
- Cox, S. J. and Bauer, J. J., 1997. Species interactions between the White-winged Chough and Australian Magpie in a fragmented landscape. *Pac. Cons. Biol.* 3: 289-94.
- Croft, J. D. and Hone, L. J., 1978. The stomach contents of foxes, *Vulpes vulpes*, collected in New South Wales. *Aust. Wildl. Res.* 5: 85-92.
- Degabriele, R., Tenison, K. and Wood, H., 1979. The avian community associated with *Eucalyptus microcarpa*. *Emu* 79: 87-89.
- Gall, B., 1982. *The south west slopes fauna survey*. Report for NSW National Parks and Wildlife Service.
- Grey, M. J., Clarke, M. F. and Loyn, R. H., 1997. Initial changes in the avian communities of remnant eucalypt woodlands following a reduction in the abundance of Noisy Miners, *Manorina melanoccephala*. *Wildl. Res.* 24: 631-48.
- Hollands, D., 1991. *Birds of the Night*. Reed Books: Balgowlah, New South Wales. 224 Pp.
- Kennedy, M., 1992. *Australasian Marsupials and Monotremes: an Action Plan for their Conservation*. International Union for Conservation of Nature and Natural Resources: Gland, Switzerland.
- Kikkawa, J. and Pearse, K., 1969. Geographical distribution of land birds in Australia — a numerical analysis. *Aust. J. Zool.* 17: 821-40.
- Loyn, R. H., 1985. Birds in fragmented forests in Gippsland, Victoria. Pp. 323-31 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management* ed by A. Keast, H. F. Recher, H. Ford and D. Saunders. Royal Australian Ornithological Union and Surrey Beatty & Sons: Sydney, New South Wales.
- Loyn, R. H., 1987. Effects of patch area and habitat on bird abundances, species numbers and tree health in fragmented Victorian forests. Chapter 6 (Pp. 65-77) in *Nature Conservation: the Role of Remnants of Native Vegetation* ed by D. A. Saunders, G. W. Arnold, A. A. Burbidge and A. J. M. Hopkins. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Lunney, D., Triggs, B., Eby, P. and Ashby, E., 1990. Analysis of scats of dogs *Canis familiaris* and foxes *Vulpes vulpes* (Canidae: Carnivora) in coastal forests near Bega, New South Wales. *Aust. Wildl. Res.* 17: 61-68.
- Lynch, J. F. and Saunders, D. A., 1991. Responses of bird species to habitat fragmentation in the wheatbelt of Western Australia: interiors, edges and corridors. Chapter 14 (Pp. 143-58) in *Nature Conservation 2: the Role of Corridors* ed by D. A. Saunders and R. J. Hobbs. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- McIntyre, S. and Barrett, G. W., 1992. Habitat variegation: an alternative to fragmentation. *Cons. Biol.* 6(1): 146-47.
- Merriam, G., 1991. Corridors and connectivity: animal populations in heterogenous environments. Chapter 13 (Pp. 133-42) in *Nature Conservation 2: the Role of Corridors* ed by D. A. Saunders and R. J. Hobbs. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Morgan, G. and Terrey, J., 1992. *Nature Conservation in Western New South Wales*. National Parks Association of NSW Inc.: Sydney, New South Wales.

- Prober, S. and Thiele, K., 1993. Surviving in cemeteries — the grassy white box woodlands. *Nat. Parks J.* Feb. 1993: 13–15.
- Robinson, D., 1994. *Research Plan for Threatened Woodland Birds of Southeastern Australia*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 133. Department of Conservation & Natural Resources, Melbourne, Victoria.
- Robinson, D. and Traill, B. J., 1996. *Conserving Woodland Birds in the Wheat and Sheep Belts of Southern Australia*. Royal Australian Ornithological Union Conservation Statement No. 10.
- Saunders, D. A., 1989. Changes in the avifauna of a region, district and remnant as a result of fragmentation of native vegetation: the wheatbelt of Western Australia. A case study. *Biol. Cons.* 50: 99–135.
- Saunders, D. A., 1994. The effects of habitat reduction and fragmentation on the mammals and birds of the Western Australian central wheatbelt: lessons for western New South Wales. Pp. 99–105 in *Future of the Fauna of Western New South Wales* ed by D. Lunney, S. Hand, P. Reed and D. Butcher. Royal Zoological Society of New South Wales: Mosman, New South Wales.
- Saunders, D. A. and de Rebeira, C. P., 1991. Values of corridors to avian populations in a fragmented landscape. Chapter 19 (Pp. 221–40) in *Nature Conservation 2: the Role of Corridors* ed by D. A. Saunders and R. J. Hobbs. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Saunders, D. A. and Hobbs, R. J., 1995. Habitat reconstruction: the revegetation imperative. Pp. 104–12 in *Conserving Biodiversity: Threats and Solutions* ed by R. A. Bradstock, T. D. Auld, D. A. Keith, R. T. Kingsford, D. Lunney and D. P. Sivertsen. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Saunders, D. A. and Ingram, J. A., 1987. Factors affecting survival of breeding populations of Carnaby's Cockatoo *Calyptorhynchus funereus latirostris* in remnants of native vegetation. Chapter 22 (Pp. 249–58) in *Nature Conservation: the Role of Remnants of Native Vegetation* ed by D. A. Saunders, G. W. Arnold, A. A. Burbidge and A. J. M. Hopkins. Surrey Beatty & Sons: Chipping Norton, New South Wales.
- Schodde, R., 1979. The mysterious origins of Australian birds. Pp. 602–05 in *Reader's Digest Complete Book of Australian Birds* ed by H. J. Frith. Reader's Digest Services: Surry Hills, New South Wales.
- Sivertsen, D., 1993. Conservation of remnant vegetation in the box and ironbark lands of New South Wales. *Vic. Nat.* 110(1): 24–29.
- State of the Environment Advisory Council, 1996. *Australia State of the Environment 1996*. CSIRO Publishing: Collingwood, Victoria.
- Strahan, R. (ed), 1995. *The Mammals of Australia*. Reed Books: Sydney, New South Wales. 756 Pp.
- Thackway, R. and Creswell, I. D. (eds), 1995. *An Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves*. Version 4.0. Australian Nature Conservation Agency, Canberra. 88 Pp.
- Triggs, B., Brunner, H. and Cullen, J. M., 1984. The food of fox, dog and cat in Croajingalong National Park, south-eastern Victoria. *Aust. Wildl. Res.* 11: 491–99.
- Wagga Wagga City Council, 1995. *Pomingalarna Park Management Plan*. Unpublished report prepared by Pomingalarna Park Management Committee for the New South Wales Department of Land and Water Conservation.
- Watts, C. H. S. and Aslin, H. J., 1981. *The Rodents of Australia*. Angus and Robertson: Australia. 321 Pp.
- Webster, R. and Ahern, L., 1992. *Management for Conservation of the Superb Parrot (Polytelis swainsonii) in New South Wales and Victoria*. Unpublished report prepared for NSW National Parks and Wildlife Service and Victorian Department of Conservation and Natural Resources.

AERIAL PHOTOGRAPHY

The Land Information Centre has New South Wales covered with beautiful high focus aerial photographs to really put conservationists in the picture. Aerial photographs are proving a valuable research tool to study boundaries, crop plantings, windbreaks, drainage works, creeks, dams, buildings, etc. for efficient land management. They allow you to see the topography of the land as you have never seen it before. With a stereoscopic viewer the contours of the land, mountains, rivers, valleys and ridges can be clearly seen in 3D. Digital scanned images are also available so you can manipulate and customize the topography on a PC. Aerial photographs can also take pride of place on a suitable wall depicting the aerial layout of your study area. For your free catalogue and information brochure contact:

The Land Information Centre
Panorama Avenue, BATHURST NSW 2795
Phone: 02 6332 8245 Fax: 02 6332 8299
E-mail: Market@lic.gov.au

OR

The Sydney Map Shop
23–33 Bridge Street, SYDNEY NSW 2000
Phone: 02 9228 6465 Fax: 02 9221 5980

[This footnote added in return for permission to use the aerial photograph free of charge.]